spectral estimate. This estimate is updated only during speech pauses as a running slow average. When speech is detected, the noise estimate is frozen.

Please amend the paragraph beginning on page 6, line 25 as follows:

A12

A noise filter calculation 40 is made based on |X(f)| and $|\hat{N}(f)|$, to calculate an attenuation function H(f). As indicated at 42, this is used to control the original noisy signal X(f) by multiplying X(f) by H(f). This signal is subject to an inverse transform and overlap-add resynthesis in known manner at 44, to provide a noise reduced signal 46. The noise reduced signal 46 in Figure 2 may correspond to either of the signals at 12 or 14 in Figure 1.

In the Claims:

Please amend claims 1-6, 8-10, 12-14, 17 and 21-24 as shown below. Furthermore, please add new claims 25-30 as shown below.

A13

1. A method of reducing noise in an input signal, said input signal containing speech and having a signal to noise ratio, the method comprising the steps:

(1) detecting the presence and absence of speech;

(2) in the absence of speech, determining a noise magnitude spectral estimate $(|\hat{N}(f)|)$;

(3) in the presence of speech, comparing the magnitude spectrum of the input signal (|X(f)|) to the noise magnitude spectral estimate $(|\hat{N}(f)|)$;

(4) calculating an attenuation function (H(f)) from the magnitude spectrum of the input signal (|X(f)|) and the noise magnitude spectral estimate $(|\hat{N}(f)|)$, the attenuation function (H(f)) being dependent on the signal to noise ratio; and,

(5) modifying the input signal by the attenuation function (H(f)) to generate a noise reduced signal wherein there is no substantial modification to the input signal for very low and for very high signal to noise ratios.

2. A method as claimed in claim 1, further comprising the steps of:

(6) supplying the input signal to an amplification unit;

(7) providing the noise reduced signal to a compression circuit which generates a control signal for the amplification unit; and

(8) controlling the amplification unit with the control signal to modify the input signal to generate an output signal with compression and reduced noise.

3. A method as claimed in claim 2, wherein step (7) comprises subjecting the input signal to an auxiliary noise reduction algorithm to generate an auxiliary noise reduced signal and providing the auxiliary noise reduced signal to the compression circuit.

4. A method as claimed in claim 3, wherein the auxiliary noise reduction algorithm comprises the method of claim 1.

5. A method as claimed in claim 3, wherein the auxiliary noise reduction algorithm is different from the method of claim 1.

6. A method as claimed in claim 25, wherein the attenuation function is calculated in accordance with the following equation:

$$H(f) = \left[\frac{|X(f)|^2 - \beta |\hat{N}(f)|^2}{|X(f)|^2} \right]^{\alpha}$$

where $H(f)$ is the attenuation function, $|X(f)|$ is the magnitude spectrum of the input signal; $|\hat{N}(f)|$ is the noise magnitude spectral estimate, β is an oversubtraction factor and α is an attenuation rule, wherein α and β are selected to give a desired attenuation function.

8. A method as claimed in claim 7, wherein the oversubtraction factor β is divided by a preemphasis function $P(f)$ to give a modified oversubtraction factor $\hat{\beta}(f)$, the

A/C

preemphasis function being such as to reduce $\widehat{\beta}(f)$ at high frequencies, and thereby reduce attenuation at high frequencies.

9. A method as claimed in claim 6, wherein the rate of change of the attenuation function (H(f)) is controlled to prevent abrupt and rapid changes in the attenuation function (H(f)).

10. A method as claimed in claim 6, wherein the attenuation function (H(f)) is calculated at successive time frames, and the attenuation function (H(f)) is calculated in accordance with the following equation:

$$G_n(f) = (1-\gamma)H(f) + \gamma G_{n-1}(f)$$

wherein $G_n(f)$ and $G_{n-1}(f)$ are the smoothed attenuation functions at the n'th and (n-1) 'th time frames, and γ is a forgetting factor.

12. A method as claimed in claim 1 which includes remotely turning noise suppression on and off.

A15

13. A method as claimed in claim 1 which includes automatically disabling noise reduction in the presence of very light noise or extremely adverse environments.

~~14. A method as claimed in claim 1 which includes detecting speech with a modified auto-correlation function.~~

17. A method as claimed in claim 1, wherein detecting the presence or absence of speech comprises:

A16

(1) taking a block of the input signal and performing an auto-correlation on that block to form a correlated signal; and,

(2) checking the correlated signal for the presence of a periodic signal having a pitch corresponding to that for a desired audio signal.

21. An apparatus, for reducing noise in an input signal, the apparatus including an input for receiving the input signal, the apparatus comprising:

(a) a compression circuit for receiving a compression control signal and generating an amplification control signal in response;

(b) an amplification unit for receiving the input signal and the amplification control signal and generating an output signal with compression and reduced noise; and,

(c) an auxiliary noise reduction unit connected to the input for generating an auxiliary noise reduced signal, the compression control signal being the auxiliary noise reduced signal.

A17

22. An apparatus as claimed in claim 27, wherein the input signal contains speech and the main noise reduction unit comprises:

(1) a detector connected to said input and providing a detection signal indicative of the presence of speech;

(2) magnitude means for determining the magnitude spectrum of the input signal ($|X(f)|$), with both the detector and the magnitude means being connected to the input of the apparatus;

(3) spectral estimate means for generating a noise magnitude spectral estimate $\left(\left|\hat{N}(f)\right|\right)$ and being connected to the detector and to the input of the apparatus;

(4) a noise filter calculation unit connected to the spectral estimate means and the magnitude means, for receiving the noise magnitude spectral estimate $\left(\left|\hat{N}(f)\right|\right)$ and magnitude spectrum of the input signal ($|X(f)|$) and calculating an attenuation function ($H(f)$); and,

(5) a multiplication unit coupled to the noise filter calculation unit and the input signal for producing the noise reduced signal.

23. An apparatus as claimed in claim 22, which includes a frequency transform means connected between said input and both of the magnitude means and the spectral estimate means for transforming the signal into the frequency domain to provide a transformed signal ($X(f)$) wherein the magnitude means determines the

magnitude spectrum (|X(f)|) from the transformed signal (X(f)), and wherein the spectral estimate means determines the noise spectral estimate $\left(\left|\hat{N}(f)\right|\right)$ from the transformed signal (X(f)) in the absence of speech, the apparatus further including inverse frequency transform means for receiving a transformed noise reduced signal from the multiplication unit, the inverse frequency transform means providing the noise reduced signal.

24. An apparatus as claimed in claim 23, wherein the noise filter calculation unit determines the square of the speech magnitude spectral estimate by subtracting the square of the noise magnitude spectral estimate from the square of the magnitude spectrum of the input signal and wherein the noise filter calculation unit calculates the attenuation function (H(f)), as a function of frequency, in accordance with the following equation:

$$H(f) = \left[\frac{|X(f)|^2 - \beta\,|\hat{N}(f)|^2}{|X(f)|^2}\right]^{\alpha}$$

where f denotes frequency, $H(f)$ is the attenuation function, $|X(f)|$ is the magnitude spectrum of the input audio signal; $\left|\hat{N}(f)\right|$ is the noise magnitude spectral estimate, β is an oversubtraction factor and α is an attenuation rule, wherein α and β are selected to give a desired attenuation function.

25. A method as claimed in claims 1, wherein the square of the speech magnitude spectral estimate $\left(\left|\hat{S}(f)\right|\right)$ is determined by subtracting the square of the noise magnitude spectral estimate $\left(\left|\hat{N}(f)\right|\right)$ from the square of the magnitude spectrum of the input signal (|X(f)|).

A18

26. A method as claimed in claim 2, wherein step (6) comprises applying steps (1) to (5) to the input signal prior to supplying the input signal to the amplification unit.

27. An apparatus as claimed in claim 21, wherein the apparatus further comprises a main noise reduction unit connected to the input for generating a noise reduced signal and supplying the noise reduced signal to the amplification unit in place of the input signal.

28. An apparatus as claimed in claim 27, wherein the main noise reduction unit and the auxiliary noise reduction unit comprise a single unit.

29. An apparatus as claimed in claim 27, wherein the auxiliary noise reduction unit is different from the main noise reduction unit.

30. An apparatus as claimed in claim 22, wherein the input signal has a signal to noise ratio and the noise filter calculation unit produces the noise reduced signal in dependence upon the signal to noise ratio, wherein there is no substantial modification to the input signal for very low and for very high signal to noise ratios.